

What is claimed is:

1. A composition comprising:

(a) a fluoropolymer comprising interpolymerized units derived from a nitrogen-containing cure site monomer;

5 (b) a catalyst composition that includes a compound having the general formula:

{RA}<sup>(-)</sup>{QR'<sup>k</sup>}<sup>(+)</sup> or the precursors thereof added separately or as a mixture;

wherein R is a C<sub>1</sub>-C<sub>20</sub> alkyl or alkenyl, C<sub>3</sub>-C<sub>20</sub> cycloalkyl or cycloalkenyl, or C<sub>6</sub>-C<sub>20</sub> aryl or aralkyl, which may be nonfluorinated, partially fluorinated, or perfluorinated, A is an acid anion or an acid derivative anion, Q is phosphorous, sulfur, nitrogen, arsenic, or antimony, each R' is, independently, hydrogen or a substituted or unsubstituted C<sub>1</sub>-C<sub>20</sub> alkyl, aryl, aralkyl, or alkenyl group, provided that when Q is nitrogen and the only fluoropolymer in the composition consists essentially of a terpolymer of tetrafluoroethylene, a perfluorovinylether, and a perfluorovinylether cure site monomer comprising a nitrile group not every R' is H, and k is the valence of Q; and

optionally (c) an alcohol of the general formula R<sup>2</sup>-OH, wherein R<sup>2</sup> is an alkyl group having from 1 to 20 carbon atoms, and wherein R<sup>2</sup> can be fluorinated.

2. A composition according to claim 1 wherein A is selected from the group consisting of:

COO, O when R is aryl or alkylaryl, SO<sub>3</sub>, SO<sub>2</sub>, SO<sub>2</sub>NH, PO<sub>3</sub>, CF<sub>3</sub>CF(CF<sub>3</sub>)CH<sub>2</sub>O, C<sub>n</sub>F<sub>2n+1</sub>CH<sub>2</sub>O

20 wherein n is 0 to 100, CH<sub>2</sub>OPO<sub>3</sub>, (CH<sub>2</sub>O)<sub>2</sub>PO<sub>2</sub>, C<sub>6</sub>H<sub>4</sub>O, OSO<sub>3</sub>, SO<sub>2</sub><sup>|</sup>NR', SO<sub>2</sub><sup>|</sup>NSO<sub>2</sub>R', and SO<sub>2</sub><sup>|</sup>CRSO<sub>2</sub>R', wherein R' is as defined in claim 1.

3. A composition according to claim 1 wherein R is selected from a non-fluorinated, partially-fluorinated, or perfluorinated group.

4. A composition according to claim 1 wherein RA has the general formula selected from RCOOM, ROSO<sub>3</sub>M, RSO<sub>3</sub>M, and ROM, wherein M is hydrogen, or an alkali or alkaline earth metal.

5. A composition according to claim 1 wherein RA is selected from the formula R<sub>x</sub>-Phy-{(CH<sub>2</sub>)<sub>n</sub>-D}<sub>m</sub> wherein each R<sub>x</sub> is the same or different C<sub>1</sub>-C<sub>10</sub> alkenyl or alkyl, x is 0 to 5, y is 0 or 1, n is 0 to 10, m is 1 to 5, and D is selected from COO, OSO<sub>3</sub>, SO<sub>3</sub>, and O (when y

is 1), provided that the sum of x and m is 6 or less and provided that x and y are not both zero; RCOO wherein R is alkenyl, an alkyl of 1 to 10 carbon atoms, or an aryl of 6 to 20 carbon atoms;  $(-)OOC-(CX_2)_n-COO^{(-)}$  wherein n is 0 to 10, X = H, F, or Cl; and Ph- $((CH_2)_p-COO^{(-)})_q$  wherein p and q are independently 1 to 4;  $CF_3CF(CF_3)CH_2O$  or  $C_nF_{2n+1}CH_2O$  wherein n is 0 to 100; and blends of two or more such compounds.

6. A composition according to claim 1 wherein RA is selected from the general formula  $(-)O_z-Ph-G_y-Ph-O_z^{(-)}$  wherein G is a bond or a difunctional aliphatic, cycloaliphatic, or C<sub>1</sub>-C<sub>13</sub> aromatic radical, or a thio, oxy, carbonyl, sulfinyl, or sulfonyl radical, G and/or Ph are optionally substituted with at least one Cl or F atom, y is 0 or 1, each z is, independently, 1 or 2, and any aromatic ring of the polyoxy compound is optionally substituted with at least one atom of Cl, F, or Br atom, or carboxyl, or an acyl radical, or an alkyl radical; and blends of two or more such compounds.

7. A composition according to claim 1 wherein RA is selected from the general formula  $(-)O-Ph-C(CX_3)_2-Ph-O^{(-)}$ , wherein X is H, Cl, or F; and blends of two or more such compounds.

8. A composition according to claim 1 wherein QR'<sub>k</sub> is selected from tetramethylphosphoniums, tributylallylphosphoniums, tributylbenzylphosphoniums, dibutyl diphenylphosphoniums, tetrabutylphosphonium, tributyl(2-methoxy)propylphosphoniums, triphenylbenzylphosphoniums, and tetraphenylphosphoniums.

9. A composition according to claim 1 wherein QR'<sub>k</sub> is selected from phenyltrimethylammoniums, tetrapentylammoniums, tetrapropylammoniums, tetrahexylammoniums, tetraheptylammoniums, tetramethylammoniums, tetrabutylammoniums, tributylbenzyl ammoniums, tributylallylammoniums, tetrabenzyllammoniums, tetraphenylammoniums, diphenyl diethylamino ammoniums, triphenylbenzylammoniums, 8-benzyl-1,8-diazabicyclo[5.4.0]undec-7-eniums, benzyltris(dimethylamino) phosphoniums, and bis(benzyldiphenyl phosphine)iminiums.

10. A composition of claim 1 wherein the catalyst composition is prepared in situ.

11. A composition according to claim 1 wherein the catalyst composition is prepared from components dissolved in a solvent.

12. A composition according to claim 1 wherein the fluoropolymer comprises interpolymerized units derived from (i) tetrafluoroethylene, and optionally (ii) one or more perfluorovinyl ethers of the formula:  $\text{CF}_2=\text{CFO}(\text{R}^2\text{fO})_a(\text{R}^3\text{fO})_b\text{R}^4\text{f}$  wherein  $\text{R}^2\text{f}$  and  $\text{R}^3\text{f}$  are the same or are different linear or branched perfluoroalkylene groups of 5 1-6 carbon atoms; a and b are, independently, 0 or an integer from 1 to 10; and  $\text{R}^4\text{f}$  is a perfluoroalkyl group of 1-6 carbon atoms.

13. A composition according to claim 12 wherein the fluoropolymer further comprises interpolymerized units derived from monomers selected from the group consisting of perfluoroolefins, partially-fluorinated olefins, non-fluorinated olefins, vinylidene fluoride, and combinations thereof.

14. A composition according to claim 1 wherein said cure site monomer is selected from a fluorinated olefin and a nitrile-containing monomer.

15. A composition according to claim 1 wherein said cure site monomer is a nitrile-containing monomer having the formula  $\text{CF}_2=\text{CFO}(\text{CF}_2)_LC\text{N}$ ;  $\text{CF}_2=\text{CFO}(\text{CF}_2)_u\text{OCF}(\text{CF}_3)\text{CN}$ ;  $15 \text{ CF}_2=\text{CFO}[\text{CF}_2\text{CF}(\text{CF}_3)\text{O}]_q(\text{CF}_2\text{O})_y\text{CF}(\text{CF}_3)\text{CN}$ ; or  $\text{CF}_2=\text{CF}[\text{OCF}_2\text{CF}(\text{CF}_3)]_r\text{O}(\text{CF}_2)_t\text{CN}$ ; wherein L = 2-12; q = 0-4; r = 1-2; y = 0-6; t = 1-4, and u = 2-6; and perfluoro(8-cyano-5-methyl-3,6-dioxa-1-octene).

16. A composition according to claim 1 further comprising a filler selected from fluoropolymer filler, carbon black, and combinations thereof.

20 17. The composition of claim 1 wherein the fluoropolymer is selected from a fluoroelastomer and a fluoroplastic.

18. The composition of claim 1 wherein the composition has an induction time below about 15 minutes at a temperature of about 175°C.

19. The composition of claim 1 wherein the composition has a scorch resistance greater than 25 the scorch resistance of a comparative composition tested at the same temperature, which comparative composition has the same fluoropolymer composition of claim 1 but with a urotropin curative.

20. The composition of claim 1 further comprising an additional curative material.

21. The composition of claim 20 wherein the additional curative material is selected from ammonia-generating compounds, substituted triazine derivatives, unsubstituted triazine derivatives, peroxides, bis-aminophenols, bis-amidooximes, and organotin compounds.

22. A shaped article comprising the fluoropolymer composition of claim 1.

5 23. The composition of claim 1 further comprising a fluoropolymer containing interpolymerized units derived from monomers selected from the group consisting of perfluoroolefins, partially-fluorinated olefins, non-fluorinated olefins, vinylidene fluoride, perfluorovinyl ethers, and combinations thereof.

10 24. The composition according to claim 23 comprising a curative that increases MDR torque in the fluoropolymer composition at 177°C by at least about 0.01 N m.

15 25. The composition of claim 23 further comprising a curative material selected from ammonium salts, ammonia-generating compounds, substituted triazine derivatives, unsubstituted triazine derivatives, peroxides, bis-aminophenols, bis-amidooximes, and organotin compounds; and optionally a coagent.

20 26. The composition of claim 25 wherein the coagent is selected from triallyl cyanurate; triallyl isocyanurate; tri(methylallyl) isocyanurate; tris(diallylamine)-*s*-triazine; triallyl phosphite; N,N-diallyl acrylamide; hexaallyl phosphoramide; N,N,N',N'-tetraalkyl tetraphthalamide; N,N,N',N'- tetraallyl malonamide; trivinyl isocyanurate; 2,4,6-trivinyl methyltrisiloxane; and tri(5-norbornene-2-methylene)cyanurate.

27. The composition of claim 25 wherein the additional fluoropolymer includes interpolymerized units containing a halogen that is capable of participation in a peroxide cure reaction and wherein the additional curative is a peroxide, and optionally further comprising a triallyl cyanurate coagent.

28. A shaped article comprising the fluoropolymer composition of claim 23.

25 29. The composition of claim 1 wherein RA is selected from the formula  $\text{CF}_3(\text{CF}_2)_n\text{COO}^{(-)}$  wherein n is 1, 2, or 6, and wherein  $\text{QR}'_k$  is selected from tetrabutylphosphonium and tributyl(2-methoxy)propylphosphonium.

30. The composition of claim 1 wherein RA is selected from the formula  $(-)OOC(CF_2)_nCOO^{(-)}$  wherein n is 2 or 4, and wherein  $QR'k$  is selected from tetrabutylphosphonium and tributyl(2-methoxy)propylphosphonium.

31. The composition of claim 1 wherein RA is selected from acetate and benzoate, and  
5 wherein  $QR'k$  is selected from tetrabutylphosphonium and tributyl(2-methoxy)propylphosphonium.

32. A method of making a fluoropolymer composition comprising the steps of:  
10 a) forming a mixture comprising a fluoropolymer having interpolymerized units derived from a nitrogen-containing cure site monomer, a catalyst composition comprising a compound having the formula:  $\{RA\}^{(-)}\{QR'k\}^{(+)}$  or the precursors thereof added separately or as a mixture, wherein R is a C<sub>1</sub>-C<sub>20</sub> alkyl or alkenyl, C<sub>3</sub>-C<sub>20</sub> cycloalkyl or cycloalkenyl, or C<sub>6</sub>-C<sub>20</sub> aryl or alkylaryl, A is an acid anion or an acid derivative anion group, which may be heterocyclic, Q is P, S, N, As, or Sb, and each R' is, independently, hydrogen or a substituted or unsubstituted C<sub>1</sub>-C<sub>20</sub> alkyl, aryl, aralkyl, or alkenyl group, provided that when Q is nitrogen and the only  
15 fluoropolymer in the composition consists essentially of a terpolymer of TFE, a perfluorovinylether, and a perfluorovinylether cure site monomer comprising a nitrile group not every R' is H, and k is the valence of Q, and optionally in the presence of an alcohol of the general formula R<sup>2</sup>-OH, wherein R<sup>2</sup> is a C<sub>6</sub>-C<sub>20</sub> alkyl group;  
20 b) shaping the mixture;  
c) curing the shaped mixture; and optionally  
d) heat aging the cured mixture.

33. A method according to claim 32 wherein the catalyst is added in a form selected from a compound and a mixture of catalyst precursors.

25 34. A method according to claim 32 wherein individual components of the catalyst are separately added to the fluoropolymer composition.

35. A method according to claim 32 wherein the step of curing further comprises press-curing and optionally post-curing.

36. A cured article prepared according to the method of claim 32.

37. A method for increasing the induction period in a curable fluoropolymer composition comprising the steps of:

a) providing a fluoropolymer comprising interpolymerized units derived from a nitrogen-containing cure site monomer; and

5 b) incorporating, into the fluoropolymer, a catalyst composition that includes a compound having the general formula:  $\{RA\}^{(-)}\{QR'k\}^{(+)}$  or the precursors thereof added separately or as a mixture, wherein R is a C<sub>1</sub>-C<sub>20</sub> alkyl or alkenyl, a C<sub>3</sub>-C<sub>20</sub> cycloalkyl or cycloalkenyl or a C<sub>6</sub>-C<sub>20</sub> aryl or alkylaryl; A is an acid anion or an acid derivative anion; Q is P, S, N, As, or Sb; each R' is, independently, hydrogen or a substituted or unsubstituted C<sub>1</sub>-C<sub>20</sub> alkyl, aryl, aralkyl, or alkenyl group, provided that when Q is N and the only fluoropolymer in the composition consists essentially of a terpolymer of TFE, a perfluorovinylether, and a perfluorovinylether cure site monomer comprising a nitrile group not every R' is H; and k is the valence of Q.

15 38. The method of claim 37 further comprising the step of incorporating an alcohol of the general formula R<sup>2</sup>-OH, wherein R<sup>2</sup> is a C<sub>1</sub>-C<sub>20</sub> alkyl group, and wherein R<sup>2</sup> can be fluorinated.

39. The method of claim 37 further comprising the step of:

c) shaping the composition.

40. The method of claim 37 further comprising the step of:

20 d) curing the shaped composition; and optionally

e) heat aging the cured composition.

41. The method of claim 40 wherein the step of curing includes press-curing, and optionally post-curing.

42. A shaped article prepared according to the method of claim 37.